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Art Unit: 2600

CLMPTO 08/04/04 JW

Add New Claims 11-61

1. A method of transmitting data as a continuous phase modulation waveform with a set of modulation indices and frequency hopping, comprising the steps of:

generating a plurality of data frames from the data;

for each data frame, coding the data into a sequence of symbols wherein the initial phase state is zero, and appending a plurality of other symbols to the sequence of symbols to form a hopping frame wherein the final phase state of the hopping frame is zero;

modulating a fixed frequency carrier with the sequence of symbols for each hopping frame with a repeated sequence comprised of the set of modulation indices; and,

transmitting the modulated hopping frame;

wherein the carrier frequency for successive hopping frames are different, thereby enabling frequency hopping transmission of the data as a continuous phase modulation waveform.

2. The method of claim 1, further comprising the step of placing a predetermined transition period between transmission of each successive hopping frame.

3. The method of claim 1, wherein the set of modulation indices includes odd and even modulation indices and the odd modulation index is used first.

4. The method of claim 1, wherein the phase states represented by the symbols in the hopping frame proceed in a repeated sequence of even state, odd state, odd state and even state.

5. The method of claim 1, wherein the sequence of symbols are interleaved.

Art Unit: 2600

6. A method of receiving a data signal transmitted as a continuous phase modulation waveform with a set of modulation indices over a series of different frequencies, wherein the data signal is comprised of a plurality of hopping frames, comprising the steps of:

(i) demodulating one of the hopping frames at a determined frequency and phase offset with a repeated sequence formed from the set of modulation indices to obtain a set of demodulated data symbols and a set of demodulated other symbols for each frame;

(ii) decoding the set of demodulated data symbols beginning at state "zero" to recover the data and decoding the set of other symbols to return to the zero phase state; and,

(iii) for a successive hopping frame, translating the receiver to a different frequency over a transition period thereby enabling the reception of the transmitted data.

7. The method of claim 6 wherein the step of demodulating one of the hopping frames further includes demodulating the hopping frame synchronously at a plurality of predetermined phase offsets.

8. The method of claim 6 wherein the step of demodulating one of the hopping frames further includes tracking and accumulating the frequency error during the hopping frame and carrying over the accumulated frequency error to a subsequent hopping frame.

9. The method of claim 6, wherein the step of demodulating one of the hopping frames includes circular demodulation.

10. The method of claim 6, wherein the set of modulation indices includes odd and even modulation indices and the odd modulation index is used first.

11. (new) The method of claim 2, wherein the predetermined transition period is a multiple of 4 symbol periods.

12. (new) The method of claim 1, wherein the coding is trellis coding.

13. (new) The method of claim 12, wherein the sequence of symbols are Reed-Solomon coded.

14. (new) The method of claim 1, wherein the plurality of other symbols are selected from the sequence of symbols.

15. (new) The method of claim 1, wherein the hopping frame and transition period combined is 48 symbols in length.

16. (new) The method of claim 15, wherein the first 41 symbols are data symbols.

17. (new) The method of claim 15, wherein the first 40 symbols are data symbols and the 41st symbol is a pilot symbol.

18. (new) The method of claim 1, wherein the other symbols include a plurality of pilot symbols.

19. (new) The method of claim 1, wherein the continuous phase modulation waveform is rotationally invariant.

20. (new) The method of claim 1, wherein the set of modulation indices is selected from the group consisting of 4/16 and 5/16, 5/16 and 6/16, 6/16 and 7/16, and 12/16 and 13/16.

21. (new) The method of claim 20, wherein there are 16 valid phase states.

22. (new) The method of claim 5, wherein the sequence of symbols are interleaved over plural hopping frames.

Art Unit: 2600

23. (new) The method of claim 7, wherein the step of decoding the set of demodulated data symbols includes summing the resulting path metrics for each symbol for each predetermined phase offset, and selecting the phase offset with the largest total path metric sum as the valid solution.

24. (new) The method of claim 8, wherein the accumulated frequency error of a previous hopping frame is multiplied by the ratio of the frequency of a next hopping frame to the frequency of said previous hopping frame and adjusts the demodulation frequency offset for said next hopping frame.

25. (new) The method of claim 6 wherein the transmitted data signal is trellis coded.

26. (new) The method of claim 6 wherein the transmit period is a multiple of 4 symbol periods.

27. (new) The method of claim 6 wherein the hopping frame is 48 symbols in length.

28. (new) The method of claim 27 wherein the first 41 symbols are data symbols.

29. (new) The method of claim 27 wherein one of the first 41 symbols is a pilot symbol.

30. (new) The method of claim 27 wherein the 42nd, 43rd and 44th symbols are flush symbols.

31. (new) The method of claim 6 wherein the continuous phase modulation waveform is rotationally invariant.

32. (new) The method of claim 6 wherein the phase states represented by the symbols in the hopping frame cycle in a repeated sequence of even state, odd state, odd state even state.

33. (new) The method of claim 6 wherein the set of modulation indices is selected from the group consisting of 4/16 and 5/16, 5/16 and 6/16, 6/16 and 7/16, and 12/16 and 13/16.

Art Unit: 2600

34. (new) The method of claim 33 wherein there are 16 valid phase states for each known symbol.
35. (new) The method of claim 6 wherein the step of decoding includes Viterbi decoding.
36. (new) The method of claim 6 wherein the phase state is returned to zero by transition symbols.
37. (new) The method of claim 36 wherein the transition symbols are ignored at the receiver.
38. (new) A hopping frame for transmitting data in a multiple-modulation index continuous phase modulation waveform with frequency hopping, comprising:
 - a predetermined number of symbol periods;
 - a first sequence of trellis coded symbols containing the transmitted data wherein the initial phase state is zero, and the first symbol of the first sequence is located in the first symbol period; and,
 - a second sequence of trellis coded symbols, wherein the number of symbols in the second sequence is equal to the constraint length defined by the multiple modulation indices and wherein the second sequence brings the phase state at the end of the second sequence to zero and the first symbol of the second sequence is adjacent to the last symbol of the first sequence, wherein the number of symbols in the first and second sequence combined are not greater than the fixed number of symbol periods.
39. (new) The hopping frame of Claim 38 wherein the last symbol of the first sequence is a pilot symbol.
40. (new) The hopping frame of Claim 38 wherein the symbols from the second sequence comprise a set of symbols from the first sequence.

41. (new) The hopping frame of Claim 38 wherein the symbols from the third sequence comprise a set of symbols from the first sequence.
42. (new) The hopping frame of Claim 38 further comprising
a third sequence of coded symbols wherein the number of symbols in the third sequence is a multiple of four symbols and wherein the phase state at the end of the third sequence is zero and the first symbol of the third sequence is adjacent the last symbol of the second sequence and wherein the number of symbols in the first, second and third sequence are equal to the fixed number of symbol periods.
43. (new) The hopping frame of claim 42 wherein the hopping frame is 48 symbols in length.
44. (new) The hopping frame of claim 43 wherein the first 41 symbols are data symbols.
45. (new) The hopping frame of claim 44 wherein the first 40 symbols are data symbols and the 41st symbol is a pilot symbol.
46. (new) The hopping frame of claim 44 wherein the 42nd, 43rd and 44th symbols are flush symbols.
47. (new) The hopping frame of claim 46 wherein the remaining symbols are transition symbols.
48. (new) The hopping frame of claim 38 wherein the multiple modulation indices are selected from the group consisting of 4/16 and 5/16, 6/16 and 7/16, 8/16 and 9/16, and 10/16 and 11/16.
49. (new) The hopping frame of claim 38 wherein the first sequence of symbols are interleaved.

Art Unit: 2600



50. (new) The hopping frame of claim 38 wherein the first sequence of symbols are Reed-Solomon coded.

51. (new) The hopping frame of claim 42 wherein the phase state is zero at the beginning of the first sequence, the end of the second sequence and at the end of the third sequence.

52. (new) In a method of communicating data with a multiple modulation index continuous phase modulation waveform as trellis coded symbols at a fixed carrier frequency, the improvement of increasing the EDCM properties of the signal by frequency hopping, comprising the steps of: transmitting the data in a hopping frame wherein each hopping frame begins with an initial phase state of zero and ends with a final phase state of zero, and transmitting successive hopping frames at different frequencies.

53. (new) In a method of communicating data with a multiple modulation index continuous phase modulation waveform as trellis coded symbols in data frames, the improvement of increasing the data payload of the data frames comprising the steps of: receiving each data frame at a different frequency, and decoding each data frame independently of the previous data frame without pilot symbols.

54. (new) A system for improving the EDCM capabilities of a multiple modulation indices continuous phase modulation waveform communication system including a receiver, wherein the transmitted data is trellis coded and formed in a plurality of successive data packets, the improvement comprising at the receiver:

demodulating means for demodulating the data packets at a predetermined frequency and phase offset with a repeated sequence formed from a set of modulation indices thereby forming a set of demodulated symbols;

decoding means for decoding the set of demodulated data symbols wherein the decoder is sequenced to phase state "zero" at the beginning and end of each data packet; and,

switching means for switching the frequency of the demodulating means to a different frequency for each successive data packet over a predetermined transition period.

Art Unit: 2600



55. (new) The system of claim 34 wherein the demodulating means further comprises a means for demodulating the data packet synchronously at a plurality of predetermined phase offsets, thereby forming a plurality of sets of demodulated symbols.

56. (new) The system of claim 55 wherein the decoding means comprises a summing means for summing the winning path metrics for each symbol in each set of the plurality of sets of demodulated symbols.

57. (new) The system of claim 56 wherein the decoding means further comprises a processor for selecting one of the plurality of sets as a function of the total sum path metric stored in the summer for each set.

58. (new) The system of claim 54, wherein the demodulating means comprises a tracking means for tracking and accumulating the frequency error of the phase offset during for each data packet and storage means for carrying over the accumulated frequency error to the subsequent hopping frame.

59. (new) The system of claim 58, wherein the demodulating means further comprises a processor for adjusting the frequency offset for the next data packet based on the accumulated frequency error of previous data packet in the storage means and the demodulation frequency of the next data packet and the previous data packet.

60. (new) The system of claim 54 wherein the decoding means comprises a Viterbi decoder.

61. (new) The system of claim 54, further including a de-interleaver after the decoding means.